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SANDIA NATIONAL LABORATORIES
WASTE ISOLATION PILOT PLANT
TECHNICAL OPERATING PROCEDURE (TOP)
TOP 546

SAMPLE PREPARATION AND INSTALLATION PROCEDURE FOR PERMEABILITY AND SWELLING PRESSURE TESTING OF BENTONITE SEALS

Revision 2

Approved for Issuance: *Original signed by David Bullock* *10/2/97*
SNL WIPP QA Reviewer Date

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1.0 PURPOSE

The objective of this procedure is to prepare bentonite seal samples for permeability and swelling pressure testing. This procedure consists of two parts: sample preparation and sample installation.

2.0 RESPONSIBILITIES

Personnel who prepare bentonite seal samples for permeability and swelling pressure testing are responsible for using and following this procedure.

3.0 TECHNICAL, REGULATORY AND QA PROGRAM REQUIREMENT

There are no specific technical or regulatory requirements. All testing activities will comply with the SNL WIPP quality assurance program, and will be documented in scientific notebooks , as per WIPP QAP 20-2 Preparing, Reviewing and Approving Scientific Notebooks, and on the test report form in the Appendix A. Results of testing as documented in notebook shall be reviewed by the UNR PI or designee (dated and initialed). WIPP QAP 17-1, Quality Assurance Records Source Requirements and QAP 12-2, Calibration Quality Assurance Program, also must be followed where applicable.

4.0 SAFETY

This procedure does not address SNL ES&H issues. This procedure will be performed at the University of Nevada, Reno (UNR) and all test equipment and laboratory areas will comply with UNR safety requirements.

5.0 APPARATUS

1. Balance resolution of 0.5 g or better
2. Plastic mixing pan
3. Small plastic shovel or scoop
4. Distilled water supply
5. Sprayer
6. Plastic jar with air-tight cap
7. Standard proctor molds (ASTM D698-91, 6.1, ASTM D1557), or fabricated molds, sample cylinder (the attachment from the universal consolidometer), or oedometers
8. Standard compaction rammers (ASTM D698-91, ASTM D1557)
9. Funnel with special extended cylindrical spout 1 in (25.4 mm) diameter. The length of the spout should be close to the full length of the permeameter/oedometer
10. Compact compression machine

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6.0 PROCEDURE

I. Sample Preparation

1. Weigh out an appropriate amount (W) of air-dried bentonite (with predetermined water content W_i) to the nearest 1 g. The bentonite should have an excess 100-200 g over the weight needed for the sample to be prepared.

2. Determine the weight of water (W_{add}) to be added to the bentonite to render a desired water content (W_c). This weight can be calculated using the following formula:

$$W_{add} = W\left(\frac{100 - W_i}{100}\right)\left(\frac{W_c - W_i}{100}\right) \qquad (1)$$

3. Add a small amount of distilled water or brine to the bentonite and mix thoroughly. Use a plant sprayer to distribute the distilled water/brine evenly across the sample. Repeat this process several times until the water added reaches the prescribed amount.

4. Transfer the sample into a plastic jar with an air-tight cap. Let the sample cure for at least 72 hours before installing it in the permeameter/oedometer.

II. Sample Installation

1. Place a sand layer to the desired thickness of the bottom of the permeameter. Place a screen on top of the sand layer. The layer of clean sand should have a grain size between 0.841 mm (U.S. standard #20) and 0.259 mm (U.S. standard #60). May use other suitable materials to substitute for the sand layer and the screen for tests in stainless steel permeameters/oedometers.

2. Use a small shovel or scoop (if it can be lowered to placement position) to transfer the sample to the permeameter/oedometer by tilting it all a small angle and sliding it back gradually toward the center of the permeameter/oedometer so that the sample is placed as a stripe from the pereameter to the center. Turn 90 degree for the next placement. Repeat this process two more times. Spread the sample gently and evenly over the area of the permeameter/oedometer. For small diameter permeameters/oedometers, place the sample by pouring through a funnel with spout long enough to reach the placement location.

3. Repeat step 2 until the layer thickness is suitable for compaction. ASTM D2434-69, 6.4 requires that the layer be approximately equal in thickness, after compaction, to the maximum size of the particles (if sand or crushed rock is mixed), but not less than about 15 mm (0.60 in).

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6.0 PROCEDURE, Continued

4. As directed by test representative, compact each layer thoroughly to the desired density by tamping uniformly using a standard rammer compactor, or by compression with the compact compression machine. For either case, the drop height and the number of drops per layer or compression energy shall be adjusted to obtain the designed density.

5. Repeat steps 2 through 4 until the desired sample length is reached.

6. Place a screen and/or a sand layer on tope of the sample. The sample and two screens should fill the space in the mold completely if a stainless steel permeameter is used. This will hold the placement density and volume of sample without significant change during the saturation of the specimen. Don't place sand layers in oedometer. A sand layer should be place for samples installed in PVC permeameters to allow bentonite to swell during the saturation of the specimen. In this case, the swelling pressure developed in the bentonite can be reduced and will not damage the PVC pipe.

   NOTE: Measure, e.g., with a tape, changes of the sample length during saturation and permeability testing.

7. Measure sample dimensions and calculate the sample dry density, using test report form (Appendix). Samples should be labeled uniquely as follows:

BTN-E-UNR-xx-y

where

E = engineered sample (use F for field extracted sample);
BTN = bentonite seam;
UNR = responsible organization is UNR (University of Nevada, Reno)
xx = type of test for which the sample will be used, for example
- GP = Gas permeability;
- BP = Brine permeability;
- WP = Water permeability;
- MC = Moisture content;
- DC = Dynamic compaction;
- SC = Static compaction
- SP = Swelling pressure

y = test sequence number

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7.0 CALIBRATION

The balance used to weigh samples and the compact compression machine should have a valid calibration. Standard weights should be used for accuracy checking each day when the balance is used. Record S/N's of scale and standards plus results of the checks in the scientific notebooks. WIPP QAP 12-2, WIPP Calibration Quality Assurance Program should be followed where applicable.

8.0 RECORDS

All documentation of the testing activities and recording of the results should be identified as QA records as per WIPP QAP 17-1, Quality Assurance Records Source Requirements, and submitted to the SNL Principal Investigator/Sandia Delegated Representative, per their instructions. Records generated per implementation of this TOP are submitted per the specific requirements of identified QAP's below:

- Scientific Notebooks (submitted per WIPP QAP 20-2)
- Test Report Form, Appendix A (submitted per WIPP QAP 20-2)
- Calibration Records (submitted per WIPPQAP 12-2)

9.0 REFERENCES

WIPP QAP 12-2, WIPP Calibration Quality Assurance Program
WIPP QAP 17-1, WIPP Quality Assurance Records Source Requirements
WIPP QAP 20-2, Preparing, Reviewing and Approving Scientific Notebooks

ASTM D698-91. Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort [12,000 ft-lbf/ft^3 (600 kN-m/m^3)]. Annual Book of ASTM Standards, Construction, Vol., 04.08, American Society for Testing and Materials, Philadelphia.

ASTM D1557-91, "Test Method for Laboratory compaction Characteristics of Soil Using Modified Effort (56,000 ftlbf/ft^3 (2,700 kN-m/m^3))," Annual Book of ASTM Standards, Construction, Vol. 04.08, American Society for Testing and Materials, Philadelphia.

ASTM D2434-68. Standard Test Meshed for Permeability of Granular Soils (Constant Head). Annual Book of ASTM Standards, Construction, Vol. 04.08, American Society for Testing and Materials, Philadelphia.

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10.0 APPENDICES

Appendix A: Test Report Form: The Permeability/Swelling Pressure Test for Bentonite Seals

APPENDIX A

Test Report From: The permeability/Swelling Pressure Test for Bentonite Seals

Test Number:	Test Type ☐ Permeability ☐ PVC permeameter ☐ Stainless steel permeameter ☐ Swelling pressure
Tested by:	Brine concentration (M)
Balance Name: Calibration Exp.:	Sample density: (g/cm^3)
Compaction Method: Calibration Exp.:	Water content (%)
Brine ID:	Test Date (ended):
Material:	
Test Date (started):	

1. Balance Accuracy Checking

	Standard checking weights (g)	Balance Reading (g)
1		
2		
3		
4		
5		

2. Sample Weight (W)

W = (g)

3. Sample water content (W_c)

W_c = (%)

4. Sample Dimensions:

For measurement purpose, divide the end face of the sample into four equal sectors by drawing two mutually perpendicular diametric lines through the center. Name one as 0-180 and the other as 90-270.

1) Diameter (D)

$D_{0\text{-}180}$ = ___ ____ inch $D_{90\text{-}270}$ = ___ ____ inch
Average diameter : ____ ___ (in) x 2.54 ___ ___ (cm)

APPENDIX A (continued)

2) Sample Height **(**H)

H_0 = ___ ____ inch H_{90} = ___ ____ inch
H_{180} = ___ ____ inch H_{270} = ____ ___ inch
Average height H: ___ ____ (in) x 2.54 ___ ____ (cm)

3) Area (s) : ____ ___ (in^2) x 6.45 ___ ____ (cm^2)

4) Volume (V) : ___ ____ (in^3) x 16.39 ___ ____ (cm^3)

5) Sample Destiny (*p*)

$$\rho = W\left(1 - \frac{W_c}{100}\right)V^{-1} = \left(g / cm^3\right)$$

5. Observations: